



Press Release

Biologists Discover Origin of Stomata

Similar genetic mechanism between flowering plants and mosses is a result of evolutionary conservation

An international team has discovered a genetic mechanism that is responsible for the development of stomata – microscopic valves on the surface of plants that facilitate the uptake of carbon dioxide and the release of oxygen and water vapor. The researchers discovered this mechanism, which was previously known in flowering plants like *Arabidopsis thaliana*, in the moss *Physcomitrella patens* and found similarities between the two, implying that it already existed in the last common ancestor of mosses and flowering plants. The team was led by the biologists Professor **Ralf Reski** from the University of Freiburg/Germany and Professor **David J. Beerling** from the University of Sheffield/UK. The results were published in the journal *Nature Plants*.

Stomata came into being more than 400 million years ago when the first plants colonized the hitherto hostile land masses. Because stomata facilitate an efficient gas exchange with the atmosphere, they enabled the spread of plants and the subsequent evolution of our complex ecosystems. In contrast to more developed vascular plants with roots, stems, leaves, and vasculature, which are necessary for the transport of water and nutrients, it remained unclear in the case of mosses, which have no vasculature, which genes are responsible for the development of stomata.

The research team found that an interaction between the two proteins PpSMF1 and PpSCRM1 in *Physcomitrella* is the trigger responsible for the

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Freiburg, 28.11.2016

development of stomata in moss. When they deleted one of these genes, moss developed without stomata. The researchers found that this mechanism is similar to the interaction of the two proteins MUTE and FAMA, which triggers the development of stomata in *Arabidopsis*. The genes which encode these proteins therefore originate from the last common ancestor of mosses and flowering plants – the prehistoric plants which left the fresh water to dwell on rocks and thus laid the foundation for the development of all current ecosystems on the mainland.

“Our results show that the development of stomata originated over 400 million years ago and predated the development of roots, stems, and leaves,” explains Reski. “This evolutionary innovation fundamentally changed the global cycles of carbon, water, and energy and thus was a prerequisite for all life forms on the mainland, including us humans.”

Ralf Reski holds the Chair of Plant Biotechnology at the Faculty of Biology of the University of Freiburg/Germany. He is a founding principal investigator of the Cluster of Excellence BIOS Centre for Biological Signalling Studies.

Researchers from the LMU Munich/Germany, the University of Leeds/UK, the University of Michigan/USA, and Stanford University/USA were also involved in this study.

Original publication:

Caspar C. Chater, Robert S. Caine, Marta Tomek, Simon Wallace, Yasuko Kamisugi, Andrew C. Cuming, Daniel Lang, Cora A. MacAlister, Stuart Casson, Dominique C. Bergmann, Eva L. Decker, Wolfgang Frank, Julie E. Gray, Andrew Fleming, Ralf Reski, David J. Beerling: Origin and function of stomata in the moss *Physcomitrella patens*. *Nature Plants* 2, 16179.

Caption:

Fluorescence microscopy of *Physcomitrella* cells showing two stomata. (Photo: Dr. Stefanie Mueller)

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